

REV. 1

Model RMK 24-D

Serial No. *T.44001.*

INSTRUCTION MANUAL

KEPCO®

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SECTION I – INTRODUCTION

1-1 SCOPE OF MANUAL

- 1-2 This manual contains instructions for the installation, operation and maintenance of the Kepco RMK-D Series of switch-mode stabilized power supply modules.

1-3 GENERAL DESCRIPTION

- 1-4 Kepco RMK-D power supplies are general purpose, highly efficient, voltage stabilized d-c sources with adjustable output current limit and overvoltage protection. RMK-D power supplies operate with an efficiency greater than 70%, are equipped with soft-start circuits, can be turned on or off by TTL logic levels and can be powered by either ac or dc input sources.
- 1-5 RMK-D power supplies are identical in mechanical and electrical construction except for their output ratings, as noted in Table 1-1. RMK-D Series power supplies are completely enclosed in an aluminum case which functions as a heat sink (See Mechanical Outline Drawing, FIG. 1-4 for dimensions and finish). Removable top and bottom covers and single P-C board construction provide ready access to all components.

1-6 BLOCK DIAGRAM DESCRIPTION (Refer to FIG. 1-2)

- 1-7 A) The AC INPUT FILTER suppresses the high-frequency noise introduced by the input source and protects the input source from the reflected noise generated by the power supply.
- B) The AC LINE RECTIFIER AND FILTER converts ac line power into the required raw dc source which operates the driven POWER STAGE and the AUXILIARY DC SOURCE.

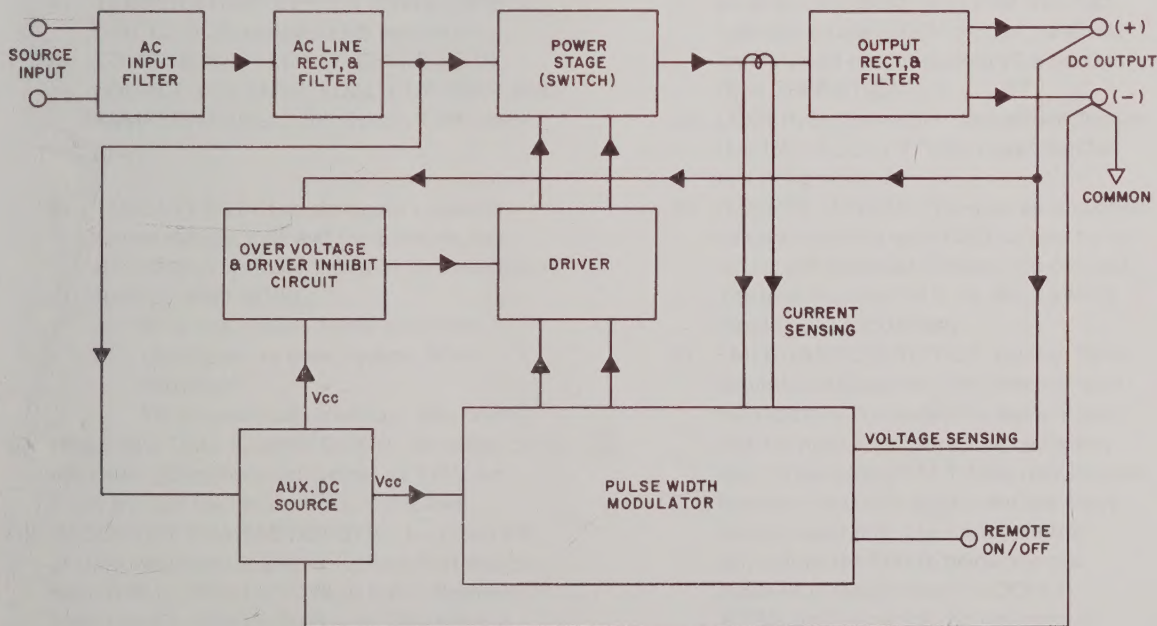


FIG. 1-2 BLOCK DIAGRAM, KEPKO RMK-D SERIES

- C) The AUXILIARY DC SOURCE provides the operating potentials for the PULSEWIDTH MODULATOR and other auxiliary circuits.

- D) The PULSEWIDTH MODULATOR is a one-chip integrated circuit containing a voltage reference, voltage mode and current limit amplifiers, an oscillator, a pulse-steering flip-flop and dual output switching transistors.

In the voltage mode of operation, the PULSEWIDTH MODULATOR provides a 20KHz push-pull pulse train for the DRIVER STAGE. The width of these pre-driver pulses is proportional to the d-c feedback from the VOLTAGE SENSING connection, i.e. for a large deviation in output voltage, a large feedback signal produces a wider pre-driver pulse for greater output from the DRIVER and the POWER STAGE with the result that the output voltage is restored to its former level.

In the event of a short circuit or an overcurrent, the CURRENT SENSING coil provides a d-c current feedback signal which activates the current limit amplifier in the PULSEWIDTH MODULATOR and takes the control away from the voltage mode amplifier. This action keeps the pre-driver pulse width, and thereby the output current value, at a predetermined level, while the output voltage complies with the load demand.

- E) The DRIVER stage accepts the processed pre-driver pulses from the PULSEWIDTH MODULATOR and in turn, provides amplified base-drive signals for the POWER STAGE. The POWER STAGE delivers the output power, via the OUTPUT RECTIFIER AND FILTER stage, to the output terminals.
- F) Protection against overvoltage at the output terminals is provided by the OVERVOLTAGE AND DRIVER INHIBIT stage. This circuit inhibits the drive to the POWER STAGE in case of an overvoltage sensed at the (+) output terminal or if the auxiliary potential is not present.



1-8 SPECIFICATIONS, ELECTRICAL, MECHANICAL

- A) A-C SOURCE INPUT: 100 to 130V a-c, 47 to 440 Hz, single phase.
- B) D-C SOURCE INPUT: 130 to 170V.
- C) D-C OUTPUT VOLTAGE: D-C OUTPUT CURRENT: See Table 1-1.

Note: RMK models will operate down to 90V a-c (or 105V d-c) with minor performance degradation.

- D) EFFICIENCY: 70% minimum, at nominal input, rated output.
- E) SOURCE INPUT CURRENT:
 - 1) @ 115VAC: 5.4A rms max.
 - 2) @ 150VDC: 4.2A dc max.
- F) OUTPUT EFFECTS:
 - 1) SOURCE EFFECT (100 to 130V a-c, 130 to 170V d-c): 0.2% typical, 0.4% maximum.
 - 2) LOAD EFFECT (10% to 100% LOAD): 0.2% typical, 0.4% maximum (See also FIG. 1-3).
 - 3) TEMPERATURE EFFECT (COEFFICIENT): 0.01% per °C typical, 0.05% per °C maximum.
 - 4) TEMPERATURE EFFECT (ENVELOPE, 0-50°C): 0.2% typical, 0.5% maximum.
 - 5) COMBINED EFFECT OF CHANGES IN SOURCE VOLTAGE, LOAD CURRENT AND TEMPERATURE: 0.6% typical, 1.4% maximum.
 - 6) TIME EFFECT (8 hr. drift): At constant source voltage, load and temperature, the 8 hr. drift is typically 0.01%, 0.05% maximum.
 - 7) RIPPLE AND NOISE:
 - a) 5mV rms typical, 10mV maximum.
 - b) 15mV peak to peak, typical, 50mV maximum.1% of rated output voltage, plus 50mV.
- G) HOLDING TIME (CARRYOVER): 20 milliseconds minimum, 30 millisecond typical, at 115V a-c input and full load at the 50°C rating level.
- H) RECOVERY CHARACTERISTIC: Less than 2% or 0.5V whichever is greater for step load changes from 50% to 100% (or 100% to 50%). Recovery occurs within 0.5% (or 0.05 volts, whichever is greater) of the original setting, within less than 1 millisecond.
- I) CURRENT LIMIT: Factory-set to 115% of the 50°C output current rating per Table 101. May be reset to accommodate the load at the 30°C rating.
- K) OVERVOLTAGE PROTECTION: The output is protected by an adjustable clamp circuit which shuts down the power supply output to zero if an overvoltage occurs. The protector is reset by removing the input source power for a minimum of 5 seconds.
- L) REMOTE TURN-ON/OFF: After the source is initially connected to the power supply, the output can be turned on and off either by means of a single-pole switch, or by a TTL logic level applied to the "RC" terminals. An internal pull-up resistor turns the power supply "on" if the remote turn-on/off terminals are not used.
- M) TEMPERATURE RANGES:
 - 1) OPERATING: 0° to 71°C ambient, 0° to 80°C heat sink temperature.See also Table 1-1 and Section II — INSTALLATION.
- N) ISOLATION: 1500V a-c between input and output terminals or case, for 1 minute, 500V d-c between output terminals and case, 10 megohm minimum.
- P) SERIES/PARALLEL: Power supplies may be series-connected up to their specified isolation voltage (500V d-c), or paralleled for increased output current (See Section III — OPERATION).
- Q) COOLING: Convection cooled. See Section II — INSTALLATION for recommended mounting methods.
- R) REMOTE SENSING: Remote sensing terminals are provided which will correct for up to 0.2 volt load-lead voltage drop per lead. The load is protected if the sensing leads should open accidentally.
- S) EMI CHARACTERISTICS: Built-in filters reduce the conducted EMI (harmonics of the switching frequency) to levels acceptable for most applications. An accessory filter, Kepco Model FLT-10A, may be used between the power supply and the input source power line. The optional filter will reduce the EMI to below the proposed FCC requirements (DOCKET 20780) and below the requirements of both, MIL. STD. 461 (LEVEL 2) and VDE EMC-0871.
- T) DIMENSIONS: See outline diagram, FIG. 1-4.
- U) WEIGHT: 9lbs, 4.1Kg.

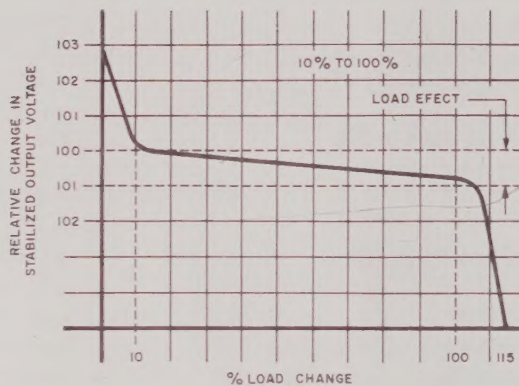


FIG. 1-3 LOAD EFFECT GRAPH, RMK-D SERIES

CAUTION

THE OUTPUT CURRENT LIMIT CONTROL (O.C.) ON EACH RMK MODEL IS SET TO APPROXIMATELY 110% OF THE 50°C RATING. IT MAY BE RESET TO THE HIGHER OUTPUT CURRENT VALUES, AS LISTED IN THE 40°C AND 30°C COLUMNS OF TABLE 1-1, BY FOLLOWING THE PROCEDURE GIVEN IN SECTION III OF THIS MANUAL.

MODEL	VOLTS (NOMINAL)	AMPS @ 30 °C	AMPS @ 40 °C	AMPS @ 50 °C	AMPS @ 60 °C	AMPS @ 71 °C
RMK 05-D	5V	75A	75A	60A	42A	30A
RMK 12-D	12V	36A	36A	32A	22A	12A
RMK 24-D	24V	18A	18A	16A	11A	6A

TABLE 1-1 RMK OUTPUT CURRENT RATINGS AT VARIOUS AMBIENT TEMPERATURES.

NOTE 1: Output current values for intermediate temperature values can be linearly interpolated.

NOTE 2: Output voltage values can be adjusted +10%, -30% around the listed values.

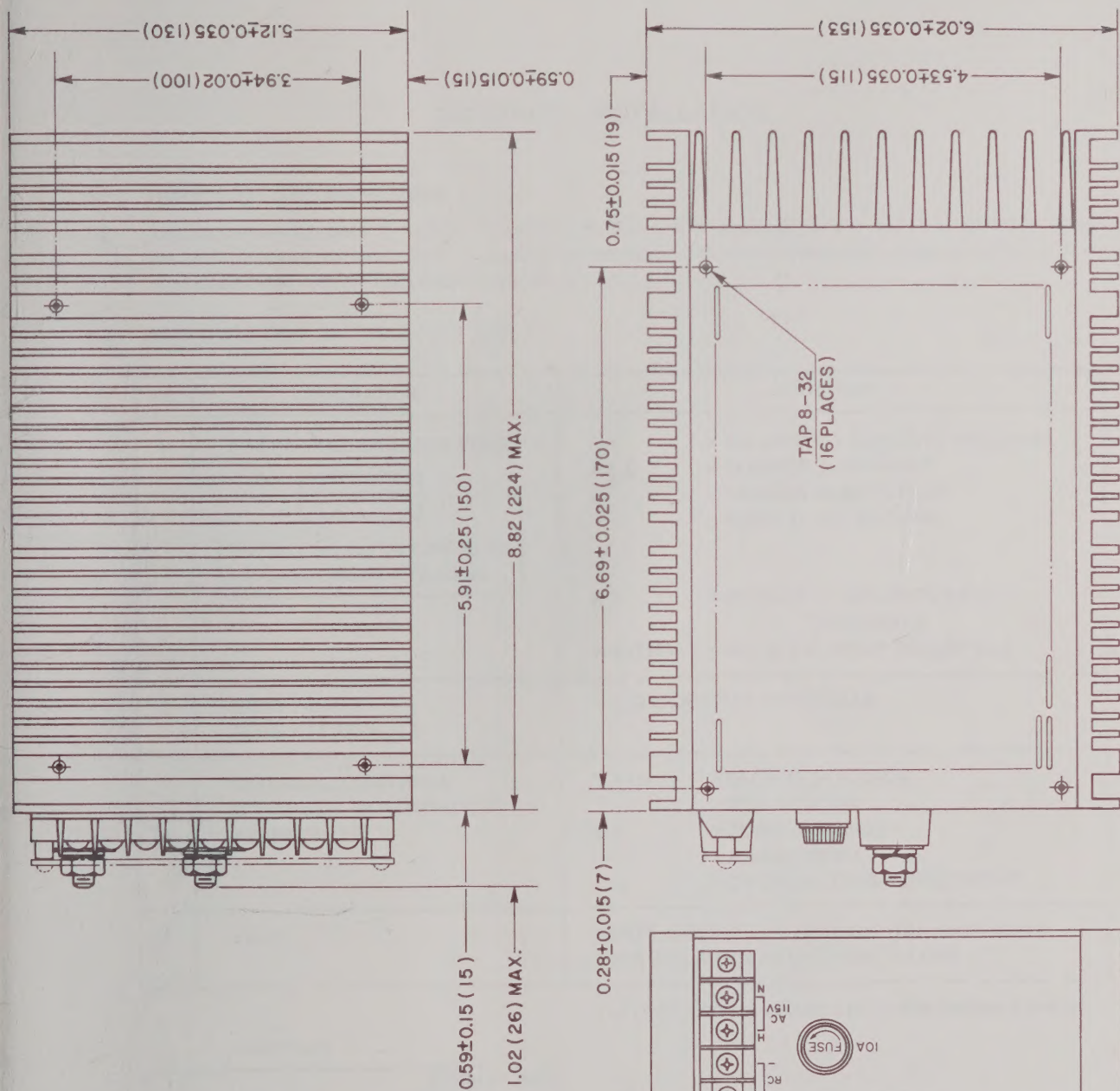


FIG. 1-4 MECHANICAL OUTLINE DRAWING, KEPCO RMK-D SERIES

- NOTES: 1. Material: Covers, 1/16 Aluminum.
 2. Finish: Phosphate treatment.
 3. Tolerances: $\pm 1/32$ (± 0.8) inch (mm).
 4. All dimensions in parentheses are in millimeter.

SECTION II – INSTALLATION

2-1 UNPACKING AND INSPECTION

- 2-2 This instrument has been thoroughly inspected and tested prior to packing and is ready for operation. Perform the preliminary operational check as outlined in paragraph 2-8. If any indication of damage is found, file an immediate claim with the responsible transport service.

2-3 TERMINATIONS: See FIG. 2-1 and Table 2-1.

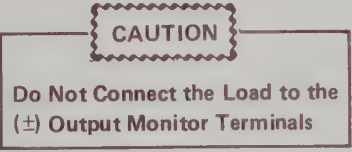
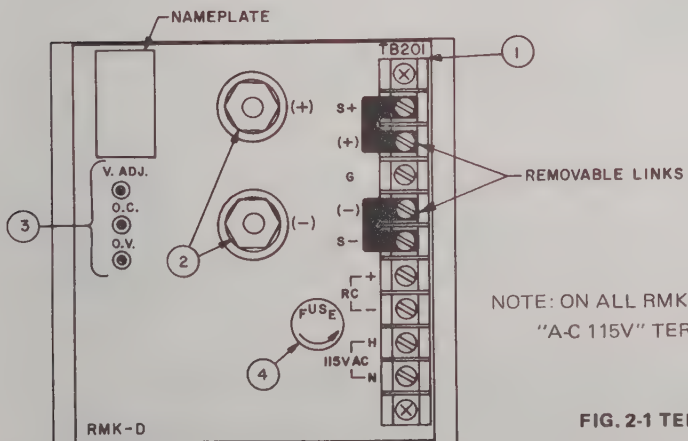
NO.	TERMINATION	FUNCTION
1	9-TERMINAL BARRIER STRIP 	-, +, S+, S-, G = D-C OUTPUT MONITOR TERMINAL = SENSING TERMINALS = CHASSIS CONNECTION: Return to A-C GROUND! + RC = REMOTE TURN-ON/TURN-OFF TERMINALS - A-C/115V = A-C or D-C INPUT TERMINALS
2	HEAVY-DUTY SCREW-TERMINALS	-, +, D-C OUTPUT TERMINALS
3	INTERNAL CONTROLS (RECESSED, SCREWDRIVER ADJUSTABLE)	V.ADJ. = OUTPUT VOLTAGE ADJUSTMENT O.C. = CURRENT LIMIT ADJUSTMENT O.V. = OVERVOLTAGE ADJUSTMENT
4	FUSE	INPUT CIRCUIT PROTECTION: 10A FAST-BLOW TYPE ALL MODELS (SEE PARTS LIST)

TABLE 2-1 TERMINATIONS, KEPKO RMK POWER SUPPLIES



NOTE: ON ALL RMK UNITS, D-C INPUT VOLTAGE MAY BE APPLIED TO "A-C 115V" TERMINALS "H" AND "N" WITHOUT REGARD TO POLARITY.

FIG. 2-1 TERMINATIONS, KEPKO RMK POWER SUPPLIES

2-4 SOURCE POWER REQUIREMENTS

- 1) A-C INPUT VOLTAGE: 115V ± 15V a-c, D-C INPUT VOLTAGE: 130 to 170V.
- 2) A-C INPUT FREQUENCY: 47 to 440 Hz, single phase.
- 3) A-C INPUT CURRENT: 5.4A rms max, D-C INPUT CURRENT: 4.2A d-c max.

2-5 SOURCE POWER TURN-ON/TURN-OFF

- 2-6 Source input power to the power supply is applied in the conventional manner by means of an external power switch in series with one or both of the source input terminals, (see FIG. 2-2).
- 2-7 Following source turn-on, for systems applications the power supply can be remotely programmed "on" and "off" by means of a contact closure, or TTL logic levels. This permits turn-on/off sequencing and avoids a-c surge currents associated with conventional a-c power turn-on/off cycles. In FIG. 2-2, both the conventional and the remote a-c power turn-on/turn-off methods are shown:
- A) If remote turn-on/off is not needed, delete components connected to terminals +RC, -RC and leave these terminals open.
 - B) If the remote control method is used, retain the SOURCE POWER switch. NOTE: Source power turn-on/turn-off must be retained since the overvoltage protector circuit is re-activated, following an overvoltage condition, by removing (5 seconds minimum) and re-applying the power. Either the indicated switch (S1) or TTL levels may be used for remote control as indicated in the table of FIG. 2-2. The switch (S1) must be "chatter-free", or the indicated components should be used to integrate the switching pulse.

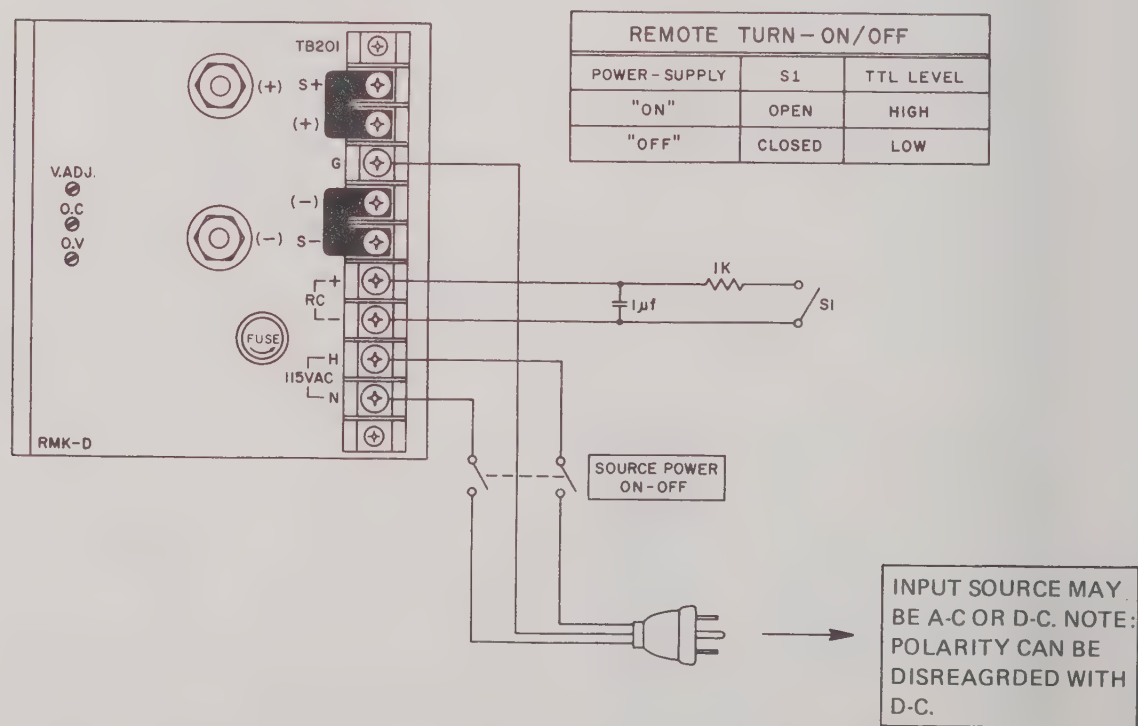


FIG. 2-2 CONVENTIONAL AND REMOTE SOURCE POWER TURN-ON/TURN-OFF.

Note: Remote turn-on/off circuit may be deleted.

2-8 PRELIMINARY CHECK-OUT

2-9 A simple operating check after unpacking and before permanent installation is advisable to ascertain whether the power supply has suffered damage resulting from shipment. Refer to FIG. 2-3 for the location of the output terminals. Connect output metering and load as shown.

- Connect power supply to 115V a-c source. Use either turn-on/turn-off method as described in PAR. 2-5 through 2-7.
- Turn the RMK power supply "on", and observe the output voltage meters (M1, M2) for the rated nominal output voltage and current of the RMK model under test.
- Check the current limit point by **reducing** the load resistance until the output voltage starts to decrease, as observed on M1. The output current value, as observed on M2, should be approximately 110% of the rated nominal output current value for the RMK power supply under test. This concludes the preliminary check-out.

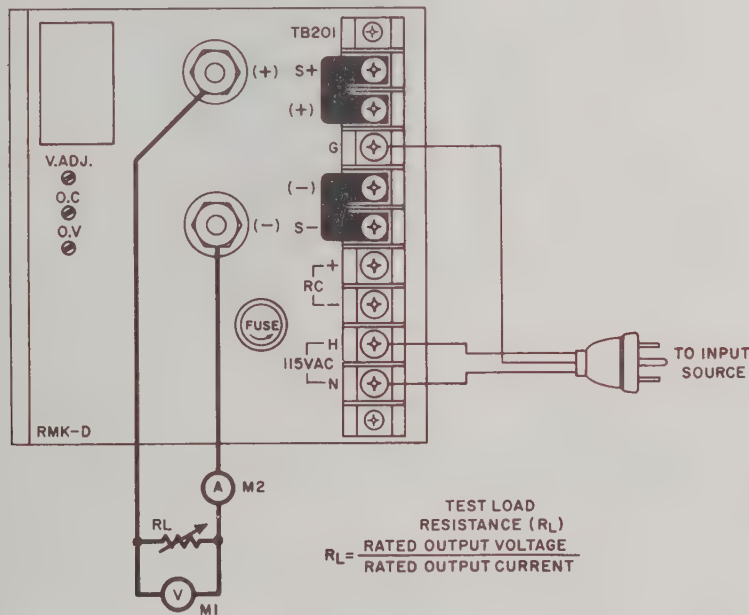


FIG. 2-3 CONNECTIONS FOR THE PRELIMINARY CHECK-OUT.

2-10 INSTALLATION AND COOLING REQUIREMENTS

2-11 GENERAL. RMK power supplies may be operated in ambient temperatures from 0 to 71°C, without forced air cooling and with the output currents as listed in Section I, Table 1-1, when mounted as described in the following paragraphs.

2-12 MOUNTING WITHOUT FORCED-AIR COOLING. FIG. 2-4 below shows the recommended mounting method for RMK—D power supplies mounted without forced-air cooling.

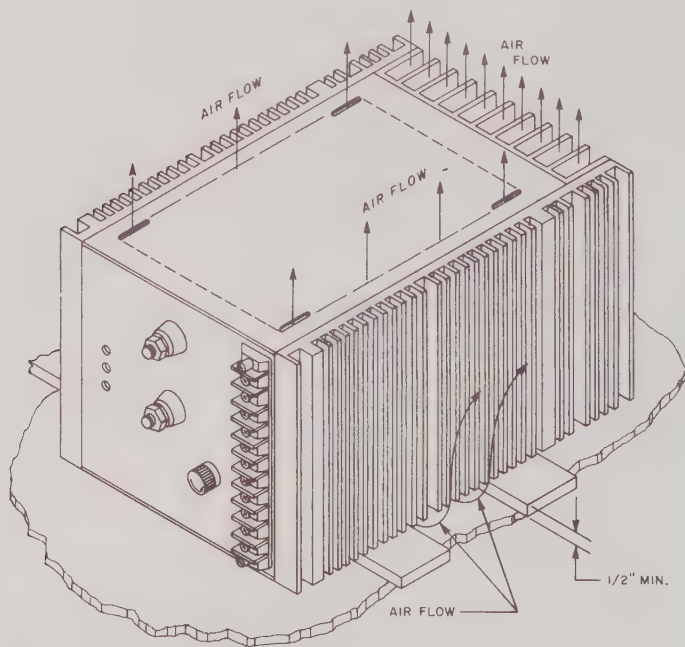


FIG. 2-4 RECOMMENDED MOUNTING METHOD (VERTICAL) FOR RMK GROUP D POWER SUPPLIES (CONVECTION COOLING), WITH STANDARD HEAT SINK.

Output current rating:
Determine ambient temperature and use Table 1-1, Section I.

CAUTION

ALL POWER SUPPLY OUTPUT CURRENT RATINGS ARE BOUND BY A MAXIMUM AVERAGE HEAT SINK TEMPERATURE OF 80°C AND BY THE MAXIMUM OUTPUT CURRENT OF EACH MODEL, AS LISTED IN THE 30°C COLUMN OF TABLE 1-1, SECTION I.

IF A RELIABLE MEANS OF DETERMINING THE HEAT SINK TEMPERATURE IS AVAILABLE, POWER SUPPLIES MAY BE MOUNTED IN ANY POSITION AND MAY BE OPERATED AT THEIR MAXIMUM CURRENT (AS LISTED IN THE 30°C COLUMN OF TABLE 1-1, SECTION I) AS LONG AS THE MEASURED AVERAGE HEAT SINK TEMPERATURE DOES NOT EXCEED 80°C. IF NECESSARY, FORCED AIR FLOW CAN BE PROVIDED TO KEEP THE HEAT SINK TEMPERATURE AT OR BELOW 80°C. FOR ADDITIONAL PROTECTION, A THERMALLY ACTUATED SWITCH CAN BE MOUNTED ONTO THE HEAT SINK, WITH ITS "NORMALLY OPEN" CONTACTS WIRED ACROSS THE POWER SUPPLY'S "RC" TERMINALS. IN THE EVENT OF AN OVER-TEMPERATURE CONDITION, THE "RC" TERMINALS WILL BE SHORTED AND THEREBY INHIBIT ALL OUTPUT FROM THE POWER SUPPLY, AS LONG AS THE OVER-TEMPERATURE CONDITION PERSISTS.

SECTION III – OPERATION

3-1 GENERAL

- 3-2 Interconnection between an a-c power source and a stabilized power supply, and between the power supply and its load are as critical as the interface between any other electronic equipment. If optimum performance is expected, certain rules for the interconnection of source, power supply and load must be observed by the user. These rules are described in detail in the following paragraphs.

3-3 SAFETY GROUNDING

- 3-4 National and international safety rules dictate the grounding of the metal cover and case of any instrument connected to the a-c power source.

WARNING

KEEP INSTRUMENT GROUNDED WHILE IT IS CONNECTED TO THE A-C POWER SOURCE

- 3-5 The recommended a-c power connections to RMK power supplies by means of a three-wire a-c line cord with grounding plug are illustrated in all diagrams in this section (Section III).

3-6 SIGNAL GROUNDING

- 3-7 Connections between the power supply and the load (load and sensing connections), will invariably, despite all precautions such as shielding, twisting of wire-pairs, etc., "pick-up" radiated noise of a wide frequency spectrum. To minimize this undesired output, a SIGNAL GROUND is needed. The signal ground consists of a single ground point, either at one of the power supply output terminals or at one side of the load.
- 3-8 Kepco has provided an internal signal ground on all models in the RMK series, consisting of a capacitor from both d-c output terminals to the chassis. If, therefore, the chassis of the RMK is a-c safety grounded by means of its three-prong plug, the safety, as well as the signal ground is automatically established.
- 3-9 The signal ground provided internally in the RMK is sufficient for performance within specifications for most applications with an isolated load. If the load has its own ground, however, or high ripple is observed during operation, an additional filter capacitor may be required directly across the load terminals.

3-10 POWER SUPPLY/LOAD INTERFACE

- 3-11 The general function of a voltage or current stabilized power supply is to deliver the rated output quantities to the connected load. The load (or loads) may have any conceivable characteristic. It may be fixed or variable, it may have predominantly resistive, capacitive, or inductive parameters, and it may be located very close to the power supply, or it may be a considerable distance away. The power supply designer cannot anticipate every conceivable application, location or nature of the load. He must design his product for the widest possible application range and specify the performance at the output terminals of the power supply. The aim of the following paragraphs is to aid the user in the final use of the product, the interface of the power supply and the load.
- 3-12 The perfect interface between a power source and its load would mean that the specified performance at the output terminals would be transferred without impairment to any load, regardless of its characteristics, distance from the power supply or environment. To approach this ideal, the power supply must satisfy certain requirements. Interconnecting rules must be closely followed and Ohm's Law, as well as basic a-c theory must be considered in selecting the interface wiring.
- 3-13 The stabilized d-c power supply is definitely not an ideal voltage or current source with zero output impedance (VOLTAGE MODE) at all frequencies. All voltage sources have some amount of impedance which increases with frequency. (Refer to FIG. 3-1.) A more realistic model for a voltage stabilized power supply must, for example, include a series resistance, representing the small d-c and low frequency source impedance, in series with an inductance, representing the source impedance at higher frequencies.

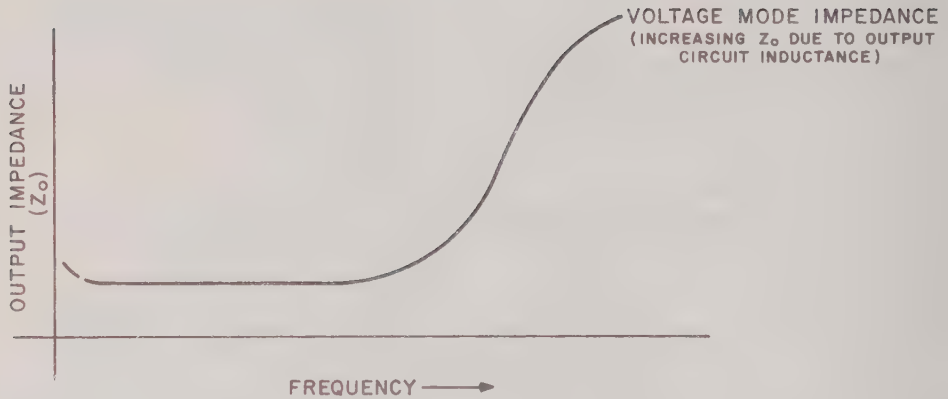


FIG. 3-1 TYPICAL OUTPUT IMPEDANCE VS. FREQUENCY
PLOT FOR STABILIZED D-C VOLTAGE SOURCES.

3-14 LOAD WIRE SELECTION

3-15 Load wire selection should proceed considering the facts discussed in PAR's 3-10 to 3-14. The load wire size should be selected for minimum voltage drop, and the series inductance of the load wire must be kept as small as possible compared to the output impedance of the power supply. These considerations are especially important if:

- 1) The load is constantly changing in value.
- 2) The load is switched "on" and "off".
- 3) The load has a primarily reactive characteristic.
- 4) The dynamic output response of the power supply is considered important.

IN PRACTICAL TERMS, THE LOAD WIRE SHOULD ALWAYS BE AS HEAVY AND AS SHORT AS POSSIBLE.

In spite of all precautions taken in interconnecting the power supply and the load, and in spite of the low ESR electrolytics and high frequency bypass capacitors used in the output of the RMK power supply, The power supply/load connection wires will "pick-up" high frequency switching noise.

An effective solution to the pick-up problem is to locate an external shunt filter directly at the load, as indicated in all connection diagrams in this section. The filter consists of a low/high frequency bypass capacitor ($C1 = 50\mu\text{F}$ electrolytic, $C2 = 0.1\mu\text{F}$ mylar, working voltages according to power supply output voltage). The given values have been used successfully for most applications.

3-16 LOAD CONNECTIONS

3-17 The load may be connected in one of the ways illustrated in FIG's 3-2 and 3-3. IMPORTANT NOTE: IF ERROR SENSING IS USED, THE SHORING LINKS BETWEEN OUTPUT AND SENSING TERMINALS MUST BE COMPLETELY REMOVED. IF ERROR SENSING IS NOT USED, THE LINKS MUST BE CONNECTED AT THE BARRIER STRIP. TIGHTEN BARRIER STRIP TERMINAL SCREWS SECURELY. LOOSE CONNECTIONS MAY CAUSE MALFUNCTIONING OF THE POWER SUPPLY.

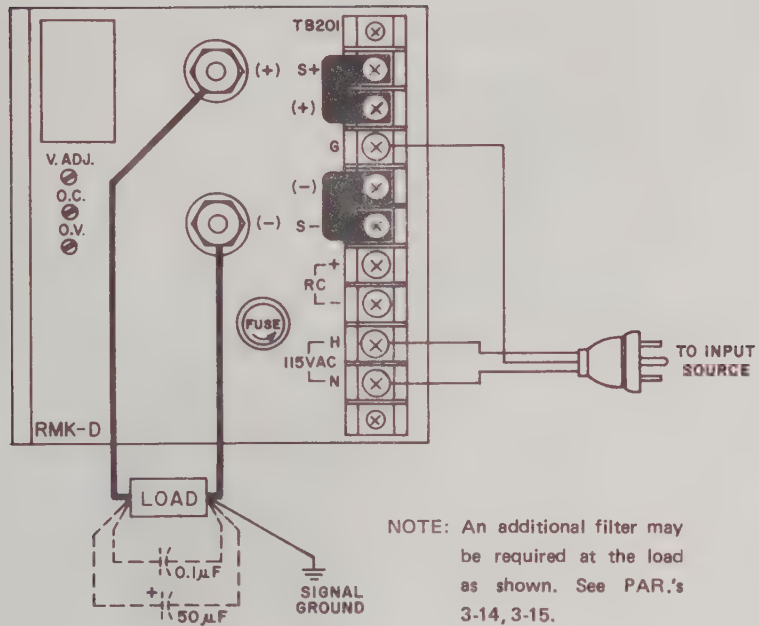


FIG. 3-2 LOAD CONNECTIONS WITHOUT ERROR SENSING

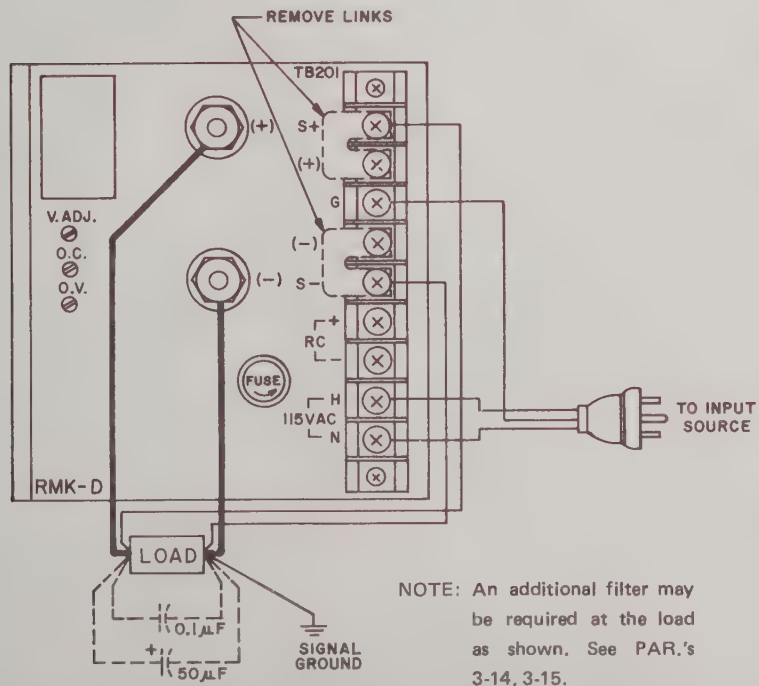


FIG. 3-3 LOAD CONNECTIONS WITH ERROR SENSING

3-18 SERIES OPERATION OF RMK POWER SUPPLIES

3-19 KEPCO RMK power supplies can be series connected for increased output voltage, provided the specified limits on voltage to chassis are not exceeded.

3-20 PROCEDURE (Refer to FIG. 3.4):

- STEP 1) Connect supplies and load as shown in FIG. 3.4. Keep voltage drop in load wires as low as possible by using proper gauge wire.
- STEP 2) Remove jumpers as shown and connect error sensing leads to load. Use at least #20 gauge wire for error sensing leads. Twist all lead pairs.
- STEP 3) Turn supplies "on" and adjust output on either one or both voltage controls as required.

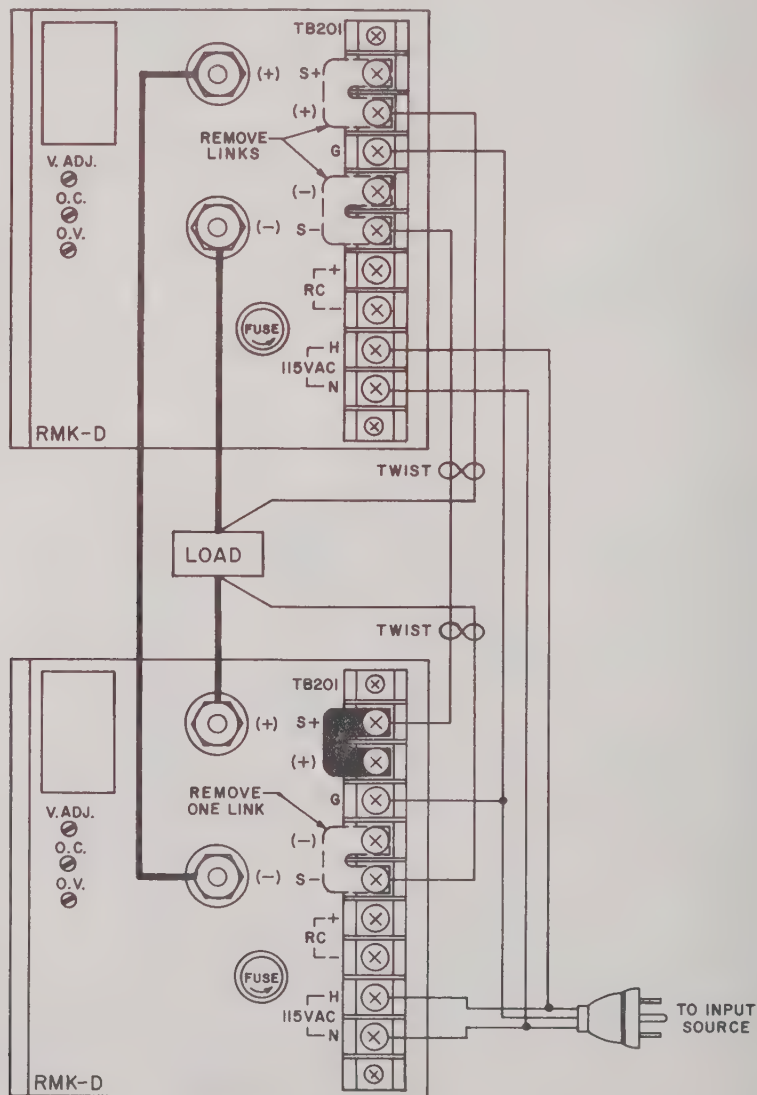


FIG. 3-4 SERIES CONNECTION OF TWO POWER SUPPLIES, WITH ERROR SENSING AT THE LOAD.

3-21 PARALLEL OPERATION OF RMK POWER SUPPLIES

3-22 When two RMK power supplies operate into a load demanding more output current than one of them can deliver, one of them will always be at a slightly higher output voltage level than the other, in spite of any attempt to equalize the output voltages before connecting the load. The supply with the higher output voltage (Supply #1) will therefore attempt to deliver all the output current, but will only be able to supply current up to its current limit setting and will then transfer into the current limit mode. The other supply (Supply #2) will now take over and deliver the balance of the output current, while operating in the "voltage mode."

NOTE: The following example describes the parallel operation of two (2) Model RMK 05-D, for a total output current of 120 amperes, with an operating voltage of 5 volts at the load and a total load wire voltage drop of 0.4 volts. The expected ambient temperature is 40°C.

A) LOAD POWER REQUIRED: $5V \times 120 A = 600 \text{ WATT}$

B) LOAD WIRE POWER LOSS: $0.4V \times 120A = 48 \text{ WATT}$

TOTAL POWER = 648 WATT

C) ONE RMK 05-D MUST SUPPLY: $648/2 = 324 \text{ WATT AT } 40^{\circ}\text{C}$.

D) A CHECK WITH THE RATING TABLE (SECTION I, TABLE 1-1) SHOWS THAT THIS IS WITHIN THE SAFE OPERATING REGION OF THE RMK 05-D (TABLE VALUE = $5V \times 75A = 375W @ 40^{\circ}\text{C}$).

3-23 PROCEDURE, PARALLEL CONNECTION OF TWO RMK POWER SUPPLIES

Set operating controls on **each** RMK as follows:

- 1) V.ADJ. control: 5.1 Volt.
- 2) O.C. control: Leave at factory setting (66 A = 110% of rated current)
- 3) O.V. control: Turn maximum clockwise.

STEP 1) Connect RMK power supplies, instrumentation and load, as shown in FIG. 3-5.

STEP 2) Turn power supply system "on" and monitor load voltage and current as indicated in FIG. 3-5.

STEP 3) With a suitable screwdriver, slowly turn V.ADJ. control of Supply #1 counterclockwise until 5.00 volts is read out on M1.

STEP 4) Turn V.ADJ. of Supply #2 slowly counterclockwise until it takes control from Supply #1 as indicated by the changing voltmeter reading on M1. Turn V.ADJ. to approximately 4.90 volts and then slowly approach 5.00 volts until Supply #2 just reaches 5.00 volts. This concludes the adjustment.

Note: Careful adjustment of the output voltage of the two supplies will result in equal current sharing and yield load effects close to that of a single unit. A carefully adjusted system should yield output voltage changes for full load to no load of approximately 60 mV.

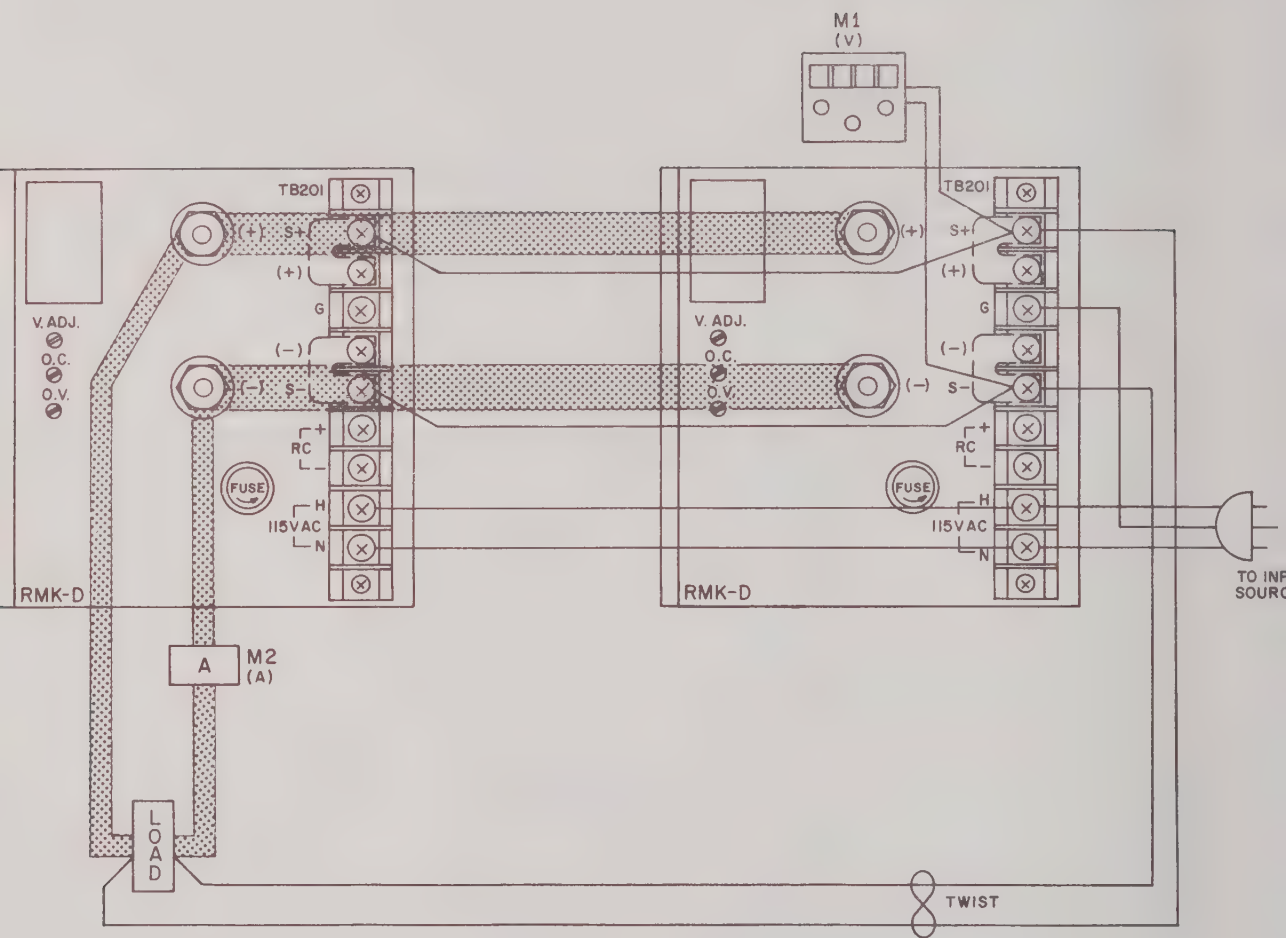


FIG. 3-5 PARALLEL CONNECTION OF TWO POWER SUPPLIES, WITH ERROR SENSING AT THE LOAD

NOTE: For parallel connections of two or more power supplies, the load leads should be as heavy and as short as possible. It is recommended, that short, heavy buss-bars are used and that the supplies are kept physically close together, as indicated in FIG. 3-5.

3-24 MULTIPLE PARALLEL CONNECTION OF RMK POWER SUPPLIES

3-25 The previously discussed concepts for paralleling RMK modules (PAR.'s 3-31 through 3-23) can be extended to include more than two power supplies, the practical limit being dictated by the larger load wire size required. The following parameters must be determined before each system's application involving multiple parallel connection of RMK Power Supplies:

- 1) REQUIRED LOAD VOLTAGE AND CURRENT
- 2) ANTICIPATED MAXIMUM AMBIENT TEMPERATURE
- 3) LOAD WIRE VOLTAGE DROP FROM THE POWER SUPPLIES TO THE LOAD MUST NOT EXCEED 0.25 VOLT PER LEAD (0.5V TOTAL).

3-26 The following example described the parallel operation of three (3) Model RMK 05—D, for a total output current of 180 Amperes with an operating potential of 5 volts at the load and a total load wire drop of 0.5 volt. The anticipated maximum ambient temperature is 40°C. A short calculation will reveal whether these parameters are within the capabilities of the proposed system:

A) LOAD POWER REQUIRED: $5V \times 180 A = 900 \text{ WATT}$

B) LOAD WIRE POWER LOSSES: $0.5V \times 180 A = 90 \text{ WATT}$

Total = 990 WATT

C) ONE RMK 05—D MUST SUPPLY $990/3 = 330 \text{ WATT}$ AT 40°C.

D) A CHECK WITH THE RATING TABLE (SECTION I, TABLE 1-1) SHOWS THAT THIS IS WITHIN THE SAFE OPERATING REGION OF THE RMK MODEL (TABLE VALUE: $5V \times 75A = 375W$ @ 40°C).

3-27 The power supplies are rack-mounted as shown in FIG. 3-6 and are, therefore, physically close together. To inter-connect the output terminals and the load, heavy copper bus-bars are used to keep voltage drops to a minimum. Wire gage for the error sensing leads and the input source wiring are noted in the set-up diagram (FIG. 3-6).

3-28 PROCEDURE, MULTIPLE PARALLEL CONNECTION OF RMK POWER SUPPLIES

Note: Before connecting the RMK supplies to the parallel set-up, turn supplies on individually and set their operating controls as follows:

RMK CONTROL	CONTROL-SETTING (ALL SUPPLIES)
V.ADJ	5.1 VOLT
O.C.	66 A (110% OF RATED CURRENT. THIS IS THE STANDARD FACTORY SETTING)
O.V.	MAXIMUM CLOCKWISE (= APPROX. 6V. THIS SETTING WILL STILL PROVIDE OVERVOLTAGE PROTECTION AND AT THE SAME TIME PREVENT FALSE TRIGGERING OF THE OVERVOLTAGE PROTECTOR.

STEP 1) Connect RMK supplies as shown in FIG. 3-6.

Note: Leave the (+) bus from Supply #2 to the load open and connect an accurate d-c ammeter of suitable range between the (+) bus and the load (M2 in FIG. 3-6). Monitor output voltage with a digital voltmeter (M1 in FIG. 3-6).

STEP 2) Turn power supply system "on" and monitor load voltage and current as indicated in FIG. 3-6.

STEP 3) With a suitable screwdriver, slowly turn V.ADJ control of Supply #1 counterclockwise until 5.00 volts is read out on M1.

STEP 4) Turn V.ADJ. of Supply #2 slowly counterclockwise until it takes control from Supply #1 as indicated by the voltmeter reading on M1. Turn V.ADJ. to approximately 4.90 volts and then slowly approach 5.00 volts until Supply #2 just reaches 5.00 volts.

STEP 5) Repeat the process described in Step #4 for Supply #3 until all supplies are operating close to the required load voltage. This concludes the adjustment.

Note: Careful adjustment of the output voltage of all supplies will result in equal current sharing and yield load effects close to that of a single unit. A carefully adjusted system should yield output voltage changes for full load to no load of approximately 60 mV.

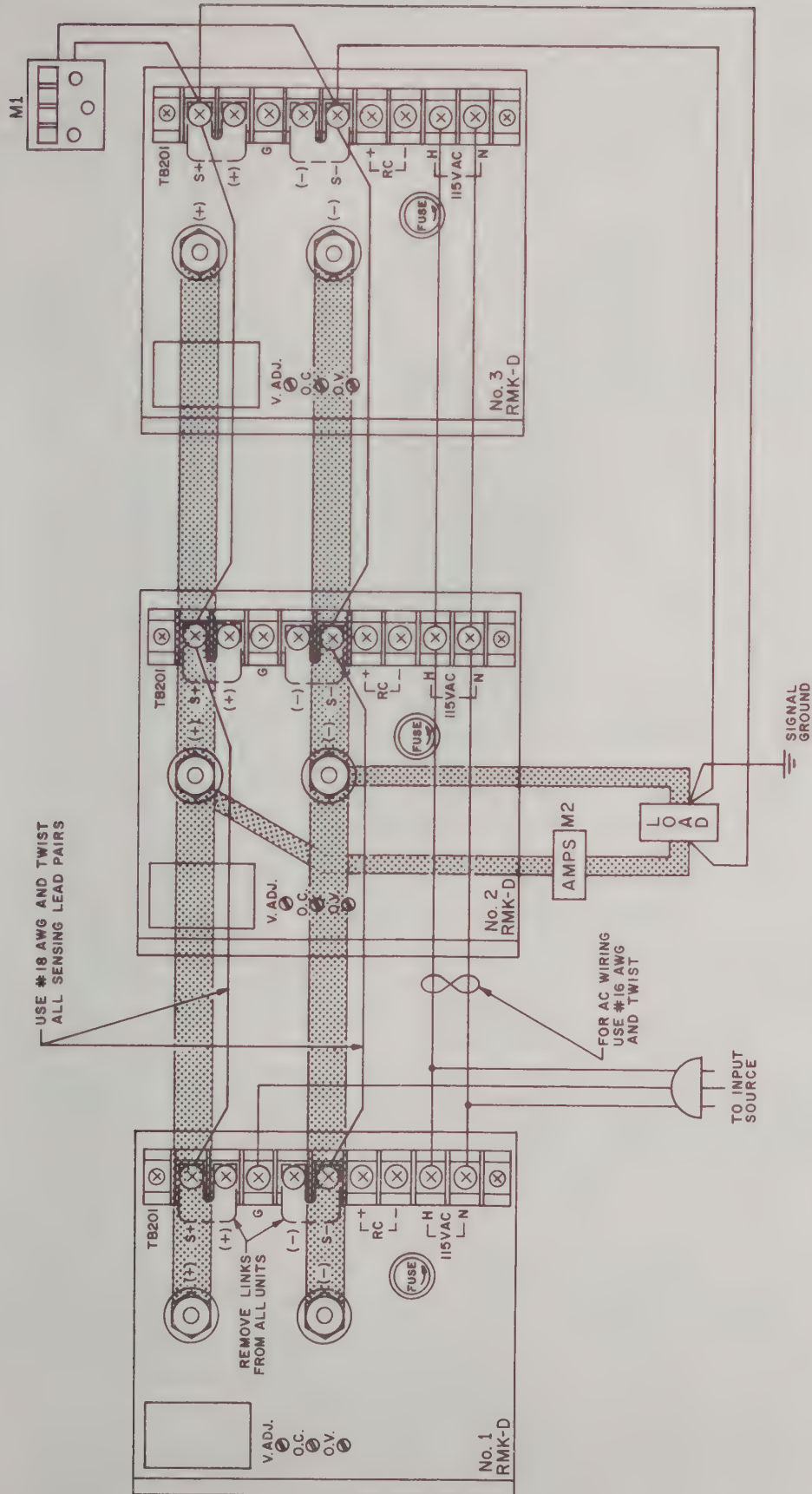


FIG. 3-6 THREE (3) POWER SUPPLIES CONNECTED IN PARALLEL, WITH ERROR SENSING AT THE COMMON LOAD.

3-29 INTERNAL CONTROLS OF THE RMK POWER SUPPLY

3-30 Three recessed, screwdriver adjustable controls have been provided on the RMK power supply. They are located to the side of the barrier strip and are clearly marked on each RMK model as follows; (Refer to FIG. 3-5, for example):

- V.ADJ = Output Voltage Adjustment
- O.C. = Current Limit Point Calibration
- O.V. = Overvoltage Limit Point Calibration

3-31 These controls are factory set to the nominal values, given in Table 3-1. The "V.ADJ" (OUTPUT VOLTAGE ADJUSTMENT) may be set to any value within the given output voltage range. The "OV" adjustment can be set approximately $\pm 5\%$ around the overvoltage limit point given in Table 3-1, thus either increasing or decreasing the threshold of the overvoltage protector. The output current limit control (O.C.) on each RMK model is set to approximately 110% of the 50°C rating. It may be reset to the higher output current values, as listed in the 40°C and 30°C columns of Table 1-1 by following the procedure given in PAR. 3-34.

NOTE: To reset any control, the locking paint around the control slot must first be carefully removed by means of a needle, or other pointed instrument. DO NOT RESET ANY CONTROL BEYOND THE VALUES GIVEN IN SECTION I, TABLE 1-1 OR IN TABLE 3-1. ALTHOUGH THIS MAY BE POSSIBLE (DUE TO COMPONENT TOLERANCES) POWER SUPPLY DAMAGE MAY RESULT. Instructions for setting the current limit and the overvoltage limit point are given in PAR. 3-34 and PAR. 3-35 respectively.

MODEL	APPROXIMATE OUTPUT VOLTAGE RANGE			OUTPUT CUR- RENT LIMIT POINT FOR 50°C AMBIENT	OVER- VOLTAGE LIMIT POINT
	MIN.	NOMINAL	MAX.		
RMK 05-D	3.5V	5V	5.5V	66A	6V
RMK 12-D	8.4V	12V	13.5V	40A	14V
RMK 24-D	16.8V	24V	26.5V	17.6A	27V

TABLE 3-1 VOLTAGE RANGE, CURRENT LIMIT AND OVERVOLTAGE SET POINTS

3-32 The standard factory-set values for all internal controls are listed in Table 3-1. Re-adjustment of these controls to other than the listed values is described in the following paragraphs:

CAUTION

RE-SETTING THE VOLTAGE ADJUSTMENT (V.ADJ.) OR THE CURRENT LIMIT (O.C.) TO HIGHER VALUES THAN THOSE LISTED IN SECTION III, TABLE 3-1 REQUIRES CAREFUL CONSIDERATION OF THE RATING TABLE, SECTION I, TABLE 1-1. OPERATION OF THE RMK BEYOND THE PARAMETERS GIVEN IN THE RATING TABLE MAY DAMAGE THE RMK POWER SUPPLY

3-33 OUTPUT VOLTAGE ADJUSTMENT (V.ADJ)

- A) Monitoring the RMK output voltage at the output terminal with an accurate voltmeter, (M1 in FIG. 3-7, set the "V.ADJ" control to the desired value. (Refer to FIG. 3-7).
- B) Multiply the adjusted output voltage value by the load current value to compute the output power. Multiply the voltage drop along the load wire (both sides) with the load current value and add this power loss to the output power. Consult the RATING TABLE (SECTION I, TABLE 1-1) and check if the computed output power plus the power loss, and the anticipated ambient temperature permit operation within the values listed in the table (see the sample calculations, par. 3-21, 3-22).

3-34 CURRENT LIMIT ADJUSTMENT (O.C.)

A) Set up the test circuit shown in FIG. 3-7. Close switch S1.

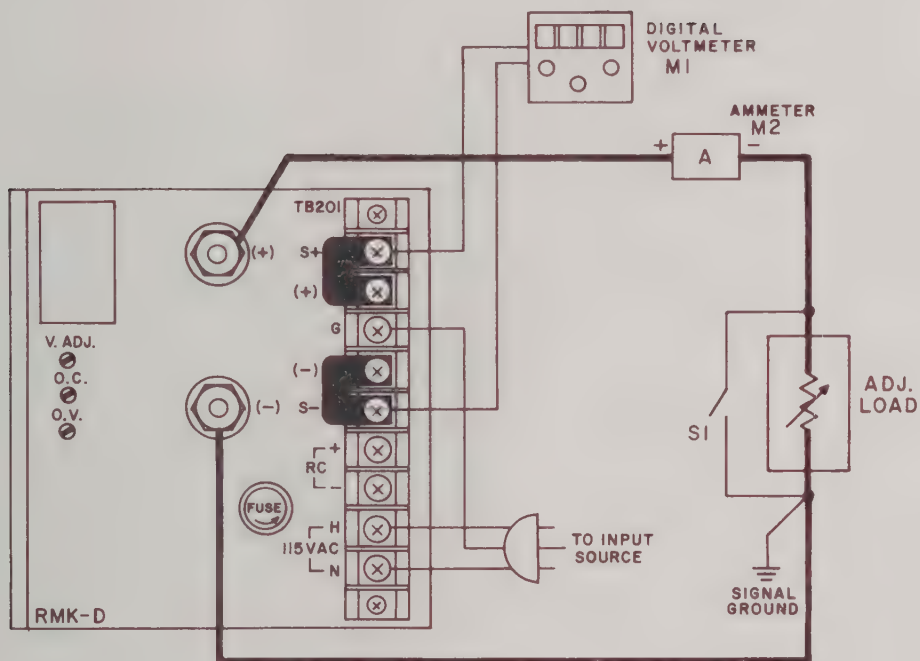
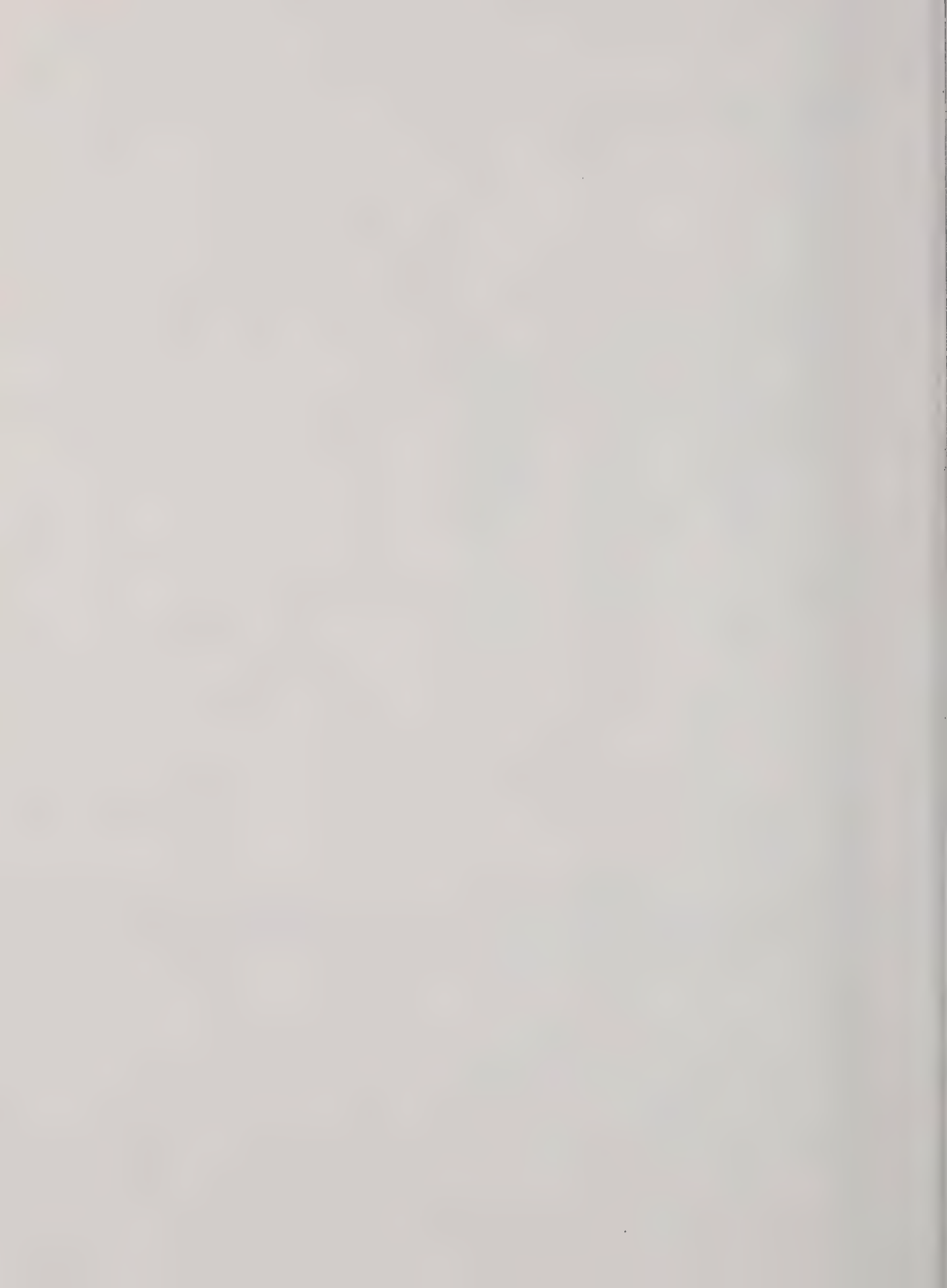


FIG. 3-7 TEST SET-UP FOR CURRENT LIMIT
AND OVERVOLTAGE ADJUSTMENTS

- B) Turn "O.C." Control to its maximum counterclockwise position. Turn A-C power "on". The d-c current read-out on M2 is the short-circuit current of the RMK under test. Adjust this current by turning the "O.C." control to your required load current value plus 10%. Set LOAD to its maximum resistance value and open S-1.
- C) Check the current limit point by adjusting the load from its maximum resistance (minimum current) toward a value yielding the required operating current. Decrease the load resistance further monitoring M1 and M2. The output voltage should start to decrease at the adjusted current limit point, approximately 10% beyond the desired operating current.

3-35 OVERVOLTAGE ADJUSTMENT (O.V.)

- A) Use the test set-up shown in FIG. 3-7, but *without* connecting the LOAD.
- B) Turn the O.V. Control to its maximum *clockwise* position. Turn a-c power "on" and adjust the VOLTAGE CONTROL ADJUSTMENT (V.ADJ) to the desired *overvoltage limit point*.
- C) Turn O.V. control slowly *counterclockwise*, until the VOLTMETER READING GOES TO ZERO.
- Note: Following the shut-down of the power supply by means of the overvoltage protector, the a-c power to the RMK power supply must be interrupted for 5 to 10 seconds, to reset the protective circuit.
- D) Reset the V.ADJ control to the desired *output voltage level*. The smallest possible "threshold" (difference between *overvoltage adjustment level* and *output voltage level*) is approximately 0.5 volts.



SECTION IV – ELECTRICAL PARTS LIST AND DIAGRAMS

4-1 GENERAL

- 4-2 This section contains the main schematic, the parts location diagrams, and a list of all replaceable electrical parts. All components are listed in alpha-numerical order of their reference designations. Consult your Kepco Representative for replacement of parts not listed here.

4-3 ORDERING INFORMATION

- 4-4 To order a replacement part or to inquire about parts not listed in the parts list, address order or inquiry either to your authorized Kepco Sales Representative or to:

KEPCO, INC.
131—38 Sanford Avenue
Flushing, N.Y. 11352

- 4-5 Specify the following information for each part:
- a) Model and complete serial number of instrument.
 - b) Kepco part number.
 - c) Circuit reference designator.
 - d) Description.
- 4-6 To order a part not listed in the parts list, give a complete description and include its function and location.

ABBREVIATIONS USED IN KEPKO PARTS LISTS

A) Reference Designators:

A	= Assembly	L	= Inductor
B	= Blower (Fan)	LC	= Light-Coupled Device
C	= Capacitor	M	= Meter
CB	= Circuit Breaker	P	= Plug
CR	= Diode	Q	= Transistor
DS	= Device, Signaling (Lamp)	R	= Resistor
F	= Fuse	S	= Switch
FX	= Fuse Holder	T	= Transformer
IC	= Integrated Circuit	TB	= Terminal Block
J	= Jack	V	= Vacuum Tube
K	= Relay	X	= Socket

B) Description Abbreviations

A	= Ampere	DC	= Direct Current
AC	= Alternating Current	DPDT	= Double Pole, Double Throw
AMP	= Amplifier	DPST	= Double Pole, Single Throw
AX	= Axial	ELECT	= Electrolytic
CAP.	= Capacitor	F	= Farad
CER	= Ceramic	FILM	= Polyester Film
CT	= Center-Tap	FLAM	= Flammable
°C	= Degree Centigrade	°F	= Degree Fahrenheit
FXD	= Fixed	RAD	= Radial
Ge	= Germanium	RECT	= Rectifier
H	= Henry	REG	= Regulated
Hz	= Hertz	RECY	= Recovery
IC	= Integrated Circuit	RES	= Resistor
K	= Kilo (10^3)	RMS	= Root Mean Square
m	= Milli (10^{-3})	Si	= Silicone
M	= Mega	S-End	= Single Ended
MFR	= Manufacturer	SPDT	= Single Pole, Double Throw
MET.	= Metal	SPST	= Single Pole, Single Throw
n	= Nano (10^{-9})	TAN	= Tantalum
NC	= Normally Closed	TSTR	= Transistor
NO	= Normally Open	u	= Micro (u) (10^{-6})
P	= Pico (10^{-12})	VAR	= Variable
PC	= Printed Circuit	V	= Volt
POT	= Potentiometer	W	= Watt
PIV	= Peak Inverse Voltage	W.W.	= Wire Wound
p-p	= Peak to Peak		
ppm	= Parts Per Million		
PWR	= Power		



KEPCO. REPLACEMENT PARTS LIST

RMK 24-D

Code 11-1077

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
C1,2	2	Cap., Film .047uF, 10%, 400V	Matsushita ECQ-F4473KZ	517-0082	1
C3,4,5,6	4	Cap., Elect., Can 470uF, +100%, -10%, 200V	Nippon Chemi-Con 200VRSN-470	517-0028	1
C7	1	Cap., Elect., S-End Leads 100uF, +50%, -10%, 10V	Nippon Chemi-Con SL10VB-100	517-0022	1
C8,13,15	3	Cap., Elect. 220uF, 20%, 16V	Nippon Chemi-Con KX16VB220	517-0122	1
C10	1	Cap., Film 4700pF, 10%, 50V	Matsushita ECQ-M05472KZ	517-0045	1
C11,18,35	3	Cap., Cer., Disc .047uF, +80%, -20%, 50V	TDK SC45F1H473Z	517-0107	1
C12	1	Cap., Elect. 33uF, 20%, 16V	Nippon Chemi-Con KX16VB33	517-0123	1
C14	1	Cap., Poly Film, Rad. Leads 4700pF, 10%, 100V	Matsushita ECQ-M1472KZ	517-0084	1
C16	1	Cap., Poly., Rad. Leads 0.01uF, 10%, 50V	Matsushita ECQ-M05103KZ	517-0003	1
C17	1	Cap., Poly., Rad. Leads 0.033uF, 10%, 50V	Matsushita ECQ-M05333KZ	517-0125	1
C19	1	Cap., Cer., Disc 470pF, 10%, 50V	TDK CK45B1H471KY	517-0024	1
C20	1	Cap., Elect., S-End Leads 2.2uF, +150%, -10%, 50V	Nippon Chemi-Con SL50VB-2.2	517-0075	1
C21	1	Cap., Film 2200pF, 10%, 600V	Matsushita ECQ-F6222KZ	517-0130	1
C23,24	2	Cap., Film .01uF, 10%, 400V	Matsushita ECQ-F4103KZ	517-0126	1
C27	1	Cap., Elect., Can 10,000uF, +50%, -10%, 25V	Nippon Chemi-Con FW35LGSN10000Y	517-0086	1
C28,38	2	Cap., Elect., Can 470uF, 20%, 35V	Nippon Chemi-Con KX35VB470	517-0124	1
C29,39	2	Cap., Poly. 0.01uF, 10%, 50V	Matsushita ECQ-M05104KZ	517-0004	1
C30,31,32, 33,36,37	6	Cap., Metal, Poly. .047uF, 30%, 630V	NTK MDI-2J0.047uH	517-0018	1
CR1	1	Rect., Bridge 400V (PIV), 15A	Shindengen S15VB40	524-0021	1
CR2,10,11, 12,13,14,16, 17,18,19	10	Diode, Switching, Ax. Leads 50V (PIV), 0.2A, 500mW	NEC 1S954	524-0008	4
CR3,4,5,6	4	Diode, Switching, Ax. Leads	NEC 1S2676	524-0029	1
CR7,8,9	3	Diode, Switching 400V (PIV), 1A	NEC 1S2674	524-0013	1
CR15	1	Diode, Rect. 200V (PIV), 1A	NEC 1S2672	524-0019	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES.

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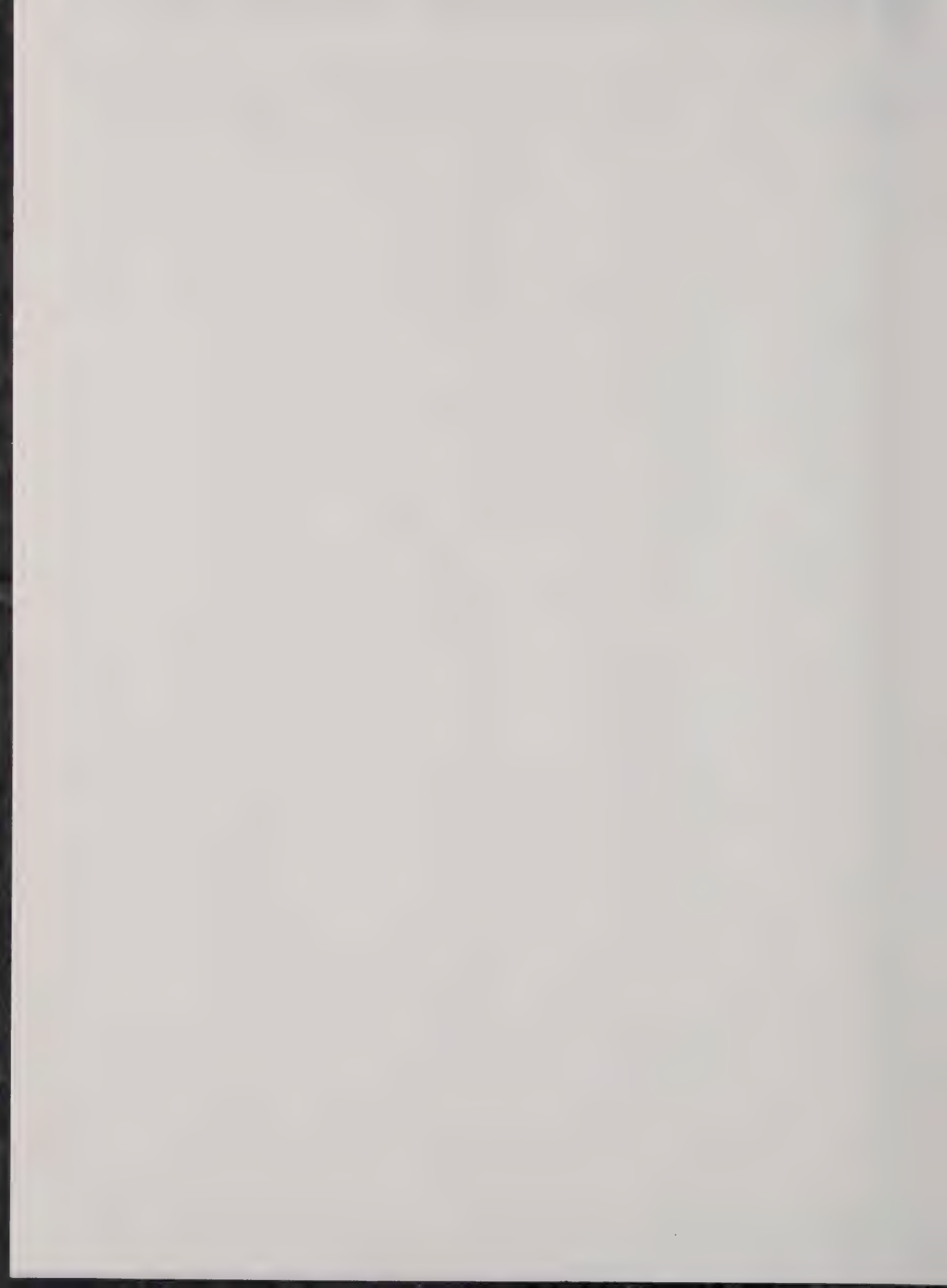
Code 11-1077

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
CR20,21	2	Diode, Rect.	Fujidenki ERE74-02	524-0031	1
CR24,25	2	Zener Diode 68V, 10%, 500mW	NEC RD68E (A)	521-0028	1
CR26	1	Zener Diode 5.6V, 3%, 500mW	NEC RD5.6E ± 3%	521-0004	1
CR27	1	Zener Diode 20V, 5%, 500mW	NEC RD20E (B)	521-0042	1
CR28	1	Zener Diode 10V, 5%, 500mW	NEC RD10E (B)	521-0008	1
CR29	1	Zener Diode 5.1V, 2%, 500mW	NEC RD5.1E ± 2%	521-0019	1
CR30	1	Thyristor, SCR 200V (PIV)	Fujidenki EGD06-02	524-0012	1
CR31	1	Zener Diode 100V, 10%, 500mW	NEC RD100E (A)	521-0014	1
F1	1	Fuse 230V, 10A	Asahi GTSAC250V10A	541-0006	5
F1X	1	Fuse Holder	Kepco Inc. 546-0003	546-0003	1
IC1	1	IC, Reg. Pulse Width Modulator	Silicon General SG1524	550-0009	1
IC2	1	IC, Comparator Amp.	Mitsubishi M51202L	550-0010	1
L1,2	2	Filter Choke, Dual Input	TDK LF003	500-0051	1
L3	1	Filter Choke Output	TDK CH046	500-0117	1
Q1,2	2	Transistor, Si, NPN Power Switching	Fujitsu 2SC2151	519-0018	1
Q3	1	Transistor, Si, NPN Power Switch	NEC 2SC1864	519-0017	1
Q4	1	Transistor, Si, NPN Power	Sanken 2SC2023	519-0009	1
Q5,7,8, 9,10	5	Transistor, Si, NPN Small Signal	Toshiba 2SC735-Y	519-0008	2
Q6	1	Transistor, PNP Small Signal	Toshiba 2SA562	519-0006	1
Q11,12	2	Transistor	Matsushita 2SC1384-R	519-0024	1
R1	1	RES., FXD, Non-Flam., W.W. 4.7 ohm, 10%, 5W	Matsushita ERF-5AK4R7	515-0202	1
R2,12,17, 45,52	5	RES., FXD, Carbon Film 1K ohm, 5%, 0.25W	Matsushita ERD-25TJ102	515-0048	2
R3	1	RES., FXD, Metal-Oxide 47 ohm, 5%, 1W	Koaohm RSF-1B470J	515-0166	1
R6	1	RES., FXD, Non-Flam., W.W. 8.2 ohm, 10%, 5W	Matsushita ERF-5AK8R2	515-0203	1

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Code 11-1077

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
R8,50	2	RES., FXD, Carbon Film 100K ohm, 5%, 0.25W	Matsushita ERD-25TJ104	515-0049	1
R9,32,33, 46,47,48	6	RES., FXD, Carbon Film 1.5K ohm, 5%, 0.25W	Matsushita ERD-25TJ152	515-0045	2
R10,20,21,43	4	RES., FXD, Carbon Film 4.7K ohm, 5%, 0.25W	Matsushita ERD-25TJ472	515-0053	2
R11	1	RES., FXD, Carbon Film 4.7 ohm, 5%, 0.25W	Matsushita ERD-25TJ4R7	515-0147	1
R13	1	RES., FXD, Carbon Film 8.2K ohm, 5%, 0.25W	Matsushita ERD-25TJ822	515-0149	1
R14,18,28, 29,51	5	RES., FXD, Carbon Film 10K ohm, 5%, 0.25W	Matsushita ERD-25TJ103	515-0055	2
R15	1	RES., FXD, Carbon Film 820 ohm, 5%, 0.25W	Matsushita ERD-25TJ821	515-0205	1
R16,23,24,26	4	RES., FXD, Carbon Film 2.7K ohm, 5%, 0.25W	Matsushita ERD-25TJ272	515-0088	1
R19,34,42	1	RES., FXD, Carbon Film 7.5K ohm, 5%, 0.25W	Matsushita ERD-25TJ752	515-0062	1
R25	1	RES., FXD, Carbon Film 3.3K ohm, 5%, 0.25W	Matsushita ERD-25TJ332	515-0047	1
R27	1	RES., FXD, Carbon Film 22K ohm, 5%, 0.25W	Matsushita ERD-25TJ223	515-0169	1
R37	1	RES., FXD, Carbon Film 330 ohm, 5%, 0.25W	Matsushita ERD-25TJ331	515-0093	1
R38	1	RES., FXD, Metal-Oxide 1.5K ohm, 5%, 1W	Koaohm RSF1B152J	515-0178	1
R39,40	2	RES., FXD, Carbon Film 68 ohm, 5%, 0.25W	Matsushita ERD-25TJ680	515-0173	1
R41	1	RES., FXD, Carbon Film 220 ohm, 5%, 0.25W	Matsushita ERD-25TJ221	515-0051	1
R44	1	RES., FXD, Carbon Film 2.2K ohm, 5%, 0.25W	Matsushita ERD-25TJ222	515-0046	1
R55,56,57	3	RES. VAR., Trim 1K ohm, 20%, 0.5W @ 70°C	Copal Electronics RJ-6X-1K ohm	515-0007	1
T1	1	Transformer, Driver	TDK PT007	500-0075	1
T2	1	Transformer, Power	TDK MT091	500-0116	1
T3	1	Transformer, Current Sensing	TDK CT001	500-0021	1
T4	1	Transformer, Auxiliary	TDK DT008	500-0080	1

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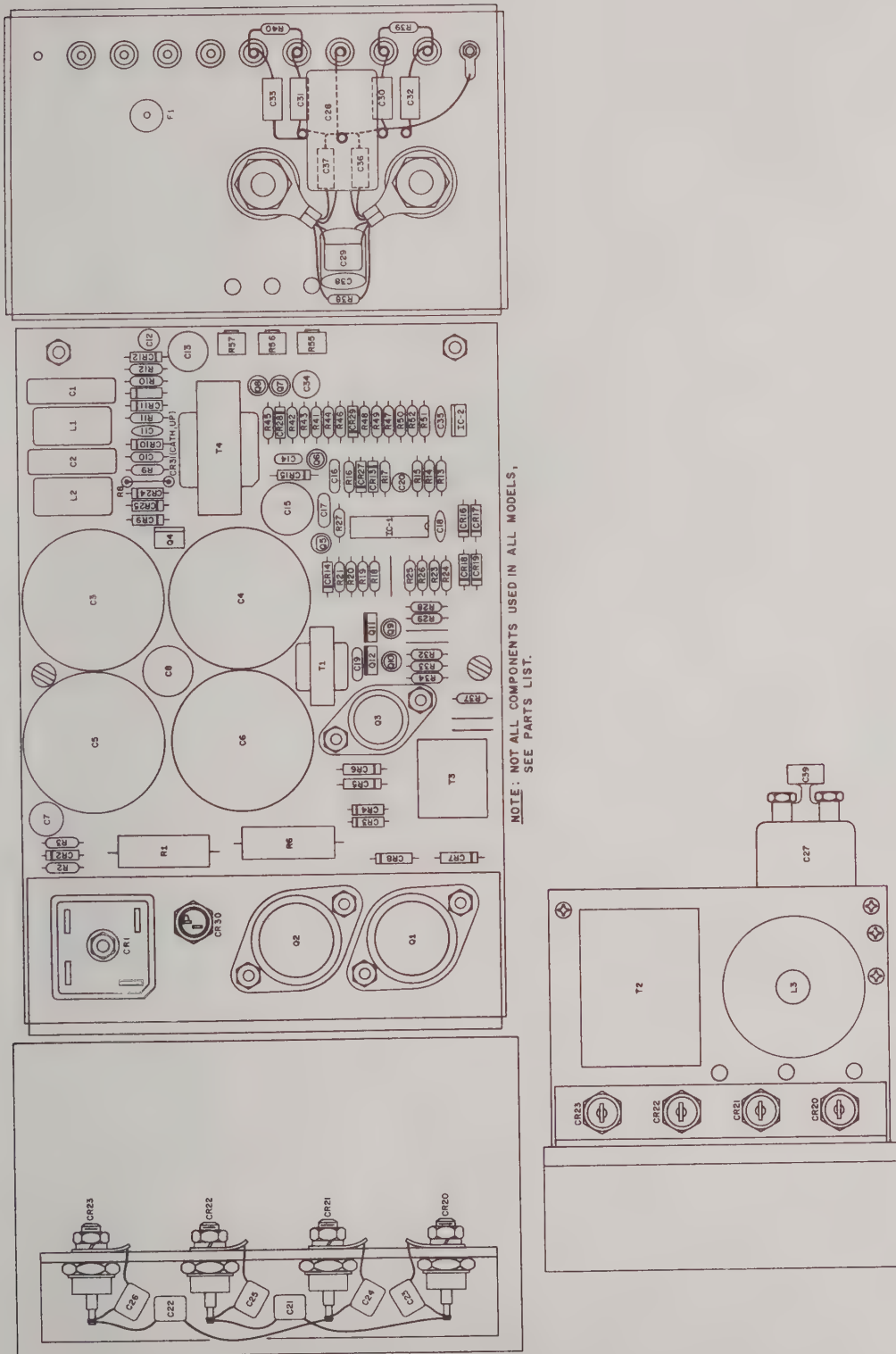
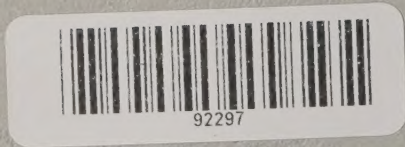


FIG. 4-1 COMPONENT LOCATION, RMK-D SERIES.





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